Oral hygiene and caries

A review

HAMILTON TADDEI BELLINI, PÅL ARNEBERG & FRITHJOF R. VON DER FEHR

Department of Periodontology and Department of Operative Dentistry, Dental Faculty, University of Oslo, Oslo, Norway

Bellini, H.T., Arneberg, P. & von der Fehr, F.R. Oral hygiene and caries. A review. *Acta Odontol. Scand.* 1981, 39, 257 - 265

On the basis of existing literature, efficient oral hygiene was found to have a caries preventive effect. The quality of the cleaning appears to be more important than the frequency of its performance. Professional tooth cleaning at regular intervals may inhibit caries on all tooth surfaces. The effect of self-performed oral hygiene has been demonstrated mainly on free smooth surfaces and on front teeth.

Key-words: Caries prevention; tooth brushing; plaque control programs; professional tooth cleaning

Pål Arneberg, Dental Faculty, Geitmyrsveien 71, Oslo 4, Norway

It is well documented that oral hygiene measures can prevent gingvitis (39, 41, 44, 46, 65), but their effect on caries has been labelled as controversial in commonly referred reviews (5, 15, 18, 31) and a recent textbook (56). However, the series of professional plaque control studies, started by the Axelsson/Lindhe group in Sweden about ten years ago (40), has created new interest in the association between mechanical oral hygiene and caries.

Fluoride has proven successful in the prevention of dental caries, but it only provides a partial solution to the caries problem. On the basis that dental plaque is a prerequisite for the development of caries (45), it was considered appropriate for the present study to review the scientific evidence related to the effect of mechanical oral hygiene measures on caries. Methods and means of plaque control and mechanisms by which plaque induces caries are beyond the scope of the present review. Relevant literature will be discussed under the following headings:

Oral cleanliness and caries

Prevalence studies based on:
1. Reported brushing frequency
2. Oral hygiene assessment

Increment (incidence) studies

Clinical trials with self-performed oral hygiene:

1. Undocumented effect on plaque
2. Ineffective plaque removal
3. Effective plaque removal

Professional tooth cleaning programs:

1. Including fluoride
2. Balancing the effect of fluoride

Received for publication, May 27, 1980

When evaluating the caries preventive effect of oral hygiene measures, the total number of lesions as well as the type of lesions may be pertinent. Published data dealing with this subject do not always permit a detailed analysis of such parameters. Therefore, percentage differences between the groups are given in Tables 1–4.

ORAL CLEANLINESS AND CARIES IN PREVALENCE STUDIES

Reported brushing frequency

Studies in this field do not give much support to the view that oral hygiene prevents caries. Mostly modest differences in total caries prevalence have been found between frequent, regular and irregular brushers (4, 19, 23, 53, 54, 62, 64) (Table 1). In one study, 3–4 times more decayed smooth surfaces were recorded among non-brushers than among daily brushers (3). In another study, 40 % lower caries prevalence was found among frequent than among infrequent brushers (14), but this difference was later attributed to the exposure to fluoridated toothpaste (60). In a study of young adults, a lower prevalence of decayed surfaces among the frequent toothbrushers was balanced by a higher prevalence of filled surfaces (23). In a group of dental students, the frequent brushers had a higher caries experience than the once daily brushers. However, the oral hygiene of the frequent brushers was no better (22).

As children grow older, DMF-figures increase and tooth-brushing habits tend to improve (53). Thus, a negative relationship between oral hygiene and caries may appear when the age factor is not taken into account (19, 53, 62). A more fundamental weakness of prevalence data is that the older the individual, the less expressive the data are for the actual caries activity.

None of the above studies tested the direct association between oral hygiene and caries prevalence. In some studies the oral hygiene tended to be better among the frequent brushers (3, 4, 14, 23, 53), but this was not always the case (22) (Table 1). Generally, reported brushing frequency bears little relation to caries prevalence.

Oral hygiene assessment

In some studies, oral hygiene was recorded as good/fair/neglected or clean/dirty, without defining the terms precisely. The «clean» mouths tended to have lower caries activity (19) or lower DMF-figures (48, 73) than the «dirty» ones, but the over all differences were small (Table 2). In one study the incisors and premolars had significantly less caries in the «good» than in the «neglected» oral hygiene group (48).

Plaque index systems are mainly developed for studying the relationship between plaque and periodontal disease, and have certain limitations regarding caries. Few lesions develop on free smooth surfaces, where plaque data are easily obtained. Most of the lesions develop in contact areas, where assessment is more difficult, and in fissures, where plaque is not recorded at all.

In some of the studies, low plaque index scores were associated with lower DMF-figures (26, 51, 59), but in others this relationship was not observed (52, 68) (Table 2).

Table 1. *Oral hygiene and caries. Prevalence studies based on reported brushing frequency*

Daily frequency	Difference in caries	Age group	Author(s)/year	Reference number
once / never	15 %	5–15	Brucker/43	19
twice / once	none	1–16	Sen Savara & Suher/55	62
regular / never	– 14 %*	12	Miller/61	54
once / <once	n.s.	4–17	McKendrick/72/73	53
twice / <once	40 %	9–13	Berenie et al./73	14
twice / once	none	13–15	Ainamo & Parviainen/79	4
twice / never	n.s.	18–24	Smith & Striffler/63	64
thrice / once	– 40 %*	20–25	Curson & Manson/65	22
thrice / once	n.s.	17–29	Dale/69	23
once / never	n.s.**	18–26	Ainamo/71	3

* higher caries prevalence among the frequent brushers
** for facial surfaces a linear decrease with increasing brushing frequency
n.s.: No statistically significant difference

Table 2. *Oral hygiene and caries. Prevalence studies based on hygiene assessments*

Hygiene criteria	Hygiene levels	Differences in caries	Age group	Author(s)/year	Reference number
–	good / neglected	16.5 %	12–14	Mansbridge/60	48
–	clean / dirty	68 %/88 %*	5–15	Brucker/43	19
–	good / neglected	15.5 %	6–17	Helsedirektoratet/73	73
Own index	4** / 1	45.5. %	6–10	McCauley & Frazier/57	51
OHI	0.4 / 2	n.s.	12–14	Trubman/63	68
Modified OHI	<5 / 10–12	n.s.	13	McHugh et al./64	52
OHI-S	<1 / >2	50.0 %	9–13	Ripa/74	59
Own index	0 / 2	***	7–15	Gülzow/65	26

* Percentage of children with active caries
** 4 is the highest level of cleanliness
*** Significantly lower DMFS scores only in the 10–12-year age group

Table 3. *The Karlstad studies (1973–1978). Annual caries increments by different professional toothcleaning frequencies*

Frequency of cleaning	Annual caries increment test	control	Caries reduction	Age group	Period	Reference number
forthnightly	0.06	3.06	98 %	7–14	1st year	40
forthnightly	0.12	3.25	94 %	8–15	2nd year	6
monthly	0.24	3.56	93 %	9–13	3rd year	42
every 2nd month	0.37	4.68	92 %	15–16	3rd year	42
every 2nd month	0.28	3.20	91 %	10–17	4th year	8
	0.03	1.53	98 %	<35		
every 2nd/3rd	0.00	0.90	100 %	36–50	three years	9
month	0.00	0.13	100 %	>50		

ORAL CLEANLINESS AND CARIES INCREMENT STUDIES

In longitudinal studies repeated assessments of oral cleanliness over two and three years have been related to the caries increments during the same period of time (12, 32, 66, 69). In all the four studies children with good oral cleanliness tended to develop less caries. However, statistical significant differences were limited to teeth erupting during the study (69), free smooth surface caries (12), or front teeth (66).

The expected relationship between oral hygiene and caries seems apparent when comparing the extremes of oral cleanliness. However, for the intermediate situations definite associations are seldom observed.

An important limitation of correlation studies is that they do not necessarily reflect a direct cause and effect relationship. Oral hygiene habits may well be associated with other caries related factors such as diet, use of fluorides, age and regular dental care. Such interference can only be eliminated by controlled clinical trials.

CLINICAL TRIALS WITH SELF-PERFORMED ORAL HYGIENE PROGRAMS

Undocumented effect on plaque

The effect on caries increments of preventive programs including oral hygiene measures has been reported both as successful (24, 35, 49, 50) and unsuccessful (25, 29, 30, 57, 70). Two studies giving separate data for anterior teeth and free smooth surfaces, showed a greater caries preventive effect on these more accessible areas (49, 70). However, the lack of plaque assessments and the fact that most of these programs (29, 30, 35, 49, 50, 57) included other preventive measures invalidate conclusions regarding oral cleanliness *per se*.

Ineffective plaque removal

Three studies on daily supervised brushing and flossing in children between 10–15 years of age gave little or no reduction of plaque scores and of caries increments over periods of one (2) and two years (33, 63). These reports illustrate the difficulties in improving the oral hygiene of children on a long-term basis (39). They provide little basic information about the hygiene/caries relationship.

Effective plaque removal

Daily brushing under supervision in 9- to 11-year-old Swedish children reduced plaque scores significantly, but not the total caries increments in the non-fluoride groups (39). However, for the buccal surfaces where brushing was most efficient the caries increment was lowered. Weekly motivation and instruction of 11–14 year old children for a period of 19 months, reduced the plaque scores, and gave a corresponding decrease in DMF increments (21). A parallel effect on plaque scores and DMF increments was also claimed by instruction programs comparing electric and manual toothbrushes (67).

Some of the trials on hygiene motivation and instruction (39, 40, 70) and a few cleanliness surveys (3, 12, 48, 66) considered the effect in different areas. The association between plaque and caries was most apparent in front teeth (48, 49, 70) and in free smooth surfaces (3, 12, 39, 49, 70). Since these areas are most easily reached by selv-applied brushing (28, 38, 43), the findings support the opinion of a direct effect of oral hygiene on caries.

It seems fair to conclude that in locations subjected to efficient hygiene, caries increments can be reduced. However, self-performed mechanical oral hygiene has not been an effective way of preventing dental caries.

Table 4. *Professional toothcleaning trials.* * *Caries increments by different cleaning frequencies*

Frequency of cleaning	Annual caries increment test	control	Caries reduction	Age group	Length of trial	Author(s)/year	Reference number
1. *Including fluoride*							
fortnightly	0.18	1.75	90 %	13–16	2 years	Karlsson & Larsson/76	34
fortnightly	**0.94	3.40	73 %	9–12	2 years	Klock & Krasse/78	37
fortnightly	**2.80	7.30	61 %	13–17	1 year	Bjørn et al./	17
monthly	3.40	4.50	24 %	10–12	1 year	Badersten et al./75	11
monthly	**1.21	3.40	64 %	9–12	2 years	Klock & Krasse/78	37
monthly	0.81	1.78	54 %	7	4 years	Bellini et al.//	13
every 3rd month	1.20	2.97	60 %	17–19	3 years	Malmberg/76	47
2. *Balancing the effect of fluoride*							
daily flossing	0.15	0.33	55 %	6	20 months	Wright et al./77/79	71/72
fortnightly	0.14	0.40	64 %	7–14	2 years	Kjaerheim et al./79	36
fortnightly	0.43	1.42	70 %	7	1 year	Poulsen et al./76	58
every 3rd week	1.40	2.09	33 %	8	1 year	Agerbaek et al./77	1
every 3rd week	2.10	4.17	51 %	7–16	3 years	Hamp et al./78	27

* Karlstad studies given in Table 3 ** Selected «risk children»

PROFESSIONAL TOOTH CLEANING PROGRAMS

Including fluoride

Regular, professional removal of plaque was the new component of the Karlstad preventive model. In the early seventies Lindhe and Axelsson started a comprehensive preventive program on a group of school children with high caries prevalence. In addition to parent engagement and diet counselling, a dedicated prophylactic nurse carried out fortnightly professional tooth cleaning with a fluoridated paste as well as giving oral hygiene instructions. The program resulted in a high level of oral cleanliness and practical eradication of caries, surpassing previous caries preventive studies (6, 40). This triggered a series of trials by the same group (Table 3) and by others (Table 4). The caries preventive effect of the Karlstad model was essentially confirmed (34) and it also proved effective on selected groups of «risk children» (17, 37).

The extention of the cleaning intervals in the Karlstad studies to one and two months did not diminish the effect during an additional two-year-period (8, 42). Treatment intervals from one to three months have given large reductions of caries in adults (9), adolescents (47, 49) and children (13), while one study gave a small reduction (11) (Table 4). On the other hand, bi-annual professional cleaning, with or without topical fluoride, did not affect oral hygiene, gingivitis or caries (61).

The caries reductions obtained in professional tooth cleaning trials which included fluoride (Table 4), greatly surpass programs based on topical fluoride alone (16, 20, 55). This suggests that the oral hygiene *per se* has a caries reducing effect. However, the separate contribution of the hygiene component cannot be estimated from the combined programs.

The few studies in which the fluoride effect can be disregarded are therefore of special interest (Table 4).

Balancing the effect of fluoride

Daily professional flossing in six-year-old children reduced approximal caries increments by 44 % during the first eight months and by 78 % during a second school year (71, 72). The study employed the half mouth technique. It was suggested that the limited preventive effect observed during the first school year might be due to small approximal lesions, undiagnosed at the baseline examination.

The forthnightly professional tooth cleaning in the Karlstad model was tested also without inclusion of fluoride. During a one year trial, caries inhibition was achieved both with and without fluoride (7), showing that the plaque control was the essential factor. When the professional tooth cleaning was substituted by supervised self-performed hygiene, part of the caries preventive effect was lost (10). This suggests that the «professional means» gave better cleaning in the caries susceptible areas. Forthnightly professional tooth cleaning and instruction over two years in low caries activity children gave 64 % less caries increments than a topical fluoride program (36).

Fortnightly professional toothcleaning with a non-fluoridated polishing paste and no special oral hygiene instruction, reduced caries increments by 70 % after one year in 7-year-old children (58). When the cleaning interval was extended from two to three weeks during a second year of the same study, part of the effect was lost (1).

In a large scale field study of 7-to 16-year-old children Hamp and coworkers applied professional tooth cleaning and hygiene instruction every third week. After one year, the caries increment was 20 % lower in the test group. The reduction reached approximately 60 % during the second and third years (27).

In conclusion, these professional tooth cleaning programs without fluoride (7, 71, 72) or with balanced fluoride regimes in the test and control groups (1, 27, 36, 58), corroborate the view that efficient oral hygiene is a caries preventive measure.

General conclusions

The remarkable caries preventive effect obtained by professional tooth cleaning contrasts the moderate and variable results by self-performed oral hygiene. Professional cleaning seems to be effective on all tooth surfaces and appears to be the more predictable method. An oral hygiene level sufficient to prevent caries, is difficult to maintain on all tooth surfaces by self-performed cleaning. Although self-performed oral hygiene has not been the most efficient way, in the combat of dental caries, some effect has been demonstrated, and combined with its beneficial effect on periodontal health, the promotion of oral hygiene procedures is justified.

It remains to be seen whether the superiority of professional cleaning is due to plaque removal in areas where self-performed programs fail, or to a more thorough surface treatment.

The existing methods for self-performed oral hygiene should be evaluated particularly as to their efficiency in removing plaque in the caries susceptible sites. For caries prevention the quality of the cleaning may be more important than its daily performance.

Acknowledgement. This review has been partially supported with a grant from the FAPESP (Fundacao de Amparo a Pesquisa do Estado de São Paulo).

REFERENCES

1. Agerbaek, N., Poulsen, S., Melsen, B. & Glavind, L. Effect of professional toothcleaning every third week on gingivitis and dental caries in children. Community Dent. Oral Epidemiol. 1977, 6, 40 – 41
2. Agerbaek, N., Melsen, B., Lind, O.P., Glavind, L. & Kristiansen, B. Effect of regular small group instruction per se on oral health status of Danish schoolchildren. Community Dent. Oral Epidemiol. 1979, 7, 17 – 20
3. Ainamo, J. The effect of habitual toothcleansing on the occurrence of periodontal disease and dental caries. Suom. Hammaslääk. Toim. 1971, 67, 63 – 70
4. Ainamo, J. & Parviainen, K. Occurrence of plaque, gingivitis and caries as related to self reported frequency of tooth-brushing in fluoride areas in Finland. Community Dent. Oral Epidemiol. 1979, 7, 142 – 146
5. Andlaw, R.H. Oral hygiene and dental caries – a review. Int. Dent. J. 1978, 28, 1 – 6
6. Axelsson, P. & Lindhe, J. The effect of a preventive programme on dental plaque, gingivitis and caries in schoolchildren. Results after one and two years. J. Clin. Periodontol. 1974, 1, 126 – 138
7. Axelsson, P. & Lindhe, J. Effect of fluoride on gingivitis and dental caries – in a preventive program based on plaque control. Community Dent. Oral Epidemiol. 1975, 3, 156 – 160
8. Axelsson, P. & Lindhe, J. The effect of a plaque control program on gingivitis and dental caries in schoolchildren. J. Dent. Res. Special Issue C 1977, 56, C142 – C148
9. Axelsson, P. & Lindhe, J. Effect of controlled oral hygiene procedures on caries and periodontal disease in adults. J. Clin. Periodontol. 1978, 5, 133 – 151
10. Axelsson, P., Lindhe, J. & Wäseby, J. The effect of various plaque control measures on gingivitis and caries in schoolchildren. Community Dent. Oral Epidemiol. 1976, 4, 232 – 239
11. Badersten, A., Egelberg, J. & Koch, G. Effect of monthly prophylaxis on caries and gingivitis in schoolchildren. Community Dent. Oral Epidemiol. 1975, 3, 1 – 4
12. Beal, J.F., James, P.M.C., Bradnock, G. & Anderson, R.J. The relationship between dental cleanliness, dental caries incidence and gingival health. A longitudinal study. Br. Dent. J. 1979, 146, 111 – 114
13. Bellini, H.T., Jacques, H.F., Paiva, Y. & Denardi, J.L. Monthly professional toothcleaning and topical fluoride over four years, in 7 – 11 years old children. II. Effect on caries. In manuscript
14. Berenie, J., Ripa, L.W. & Leske, G. The relationship of frequency of toothbrushing, oral hygiene, gingival health, and caries experience in school children. J. Public Health Dent. 1973, 33, 160 – 171
15. Bibby, B.G. Do we tell the truth about preventing caries? J. Dent. Child. 1966, 33, 269 – 279
16. Birkeland, J.M. & Torell, P. Caries-preventive fluoride mouthrinses. Caries Res. 1978, 12, suppl. 1, 38 – 51
17. Bjørn, A-L., Neime, A., Holst, K. & Nobréus, N. Utvärdering av en tvåårig verksamhet med utökade profylaktiske åtgärder på kariesaktiva barn vid Albanoskolan i Landskrona. In manuscript
18. Braune, K. & Ericsson, Y. Munhygien och karies. Tandläkartidningen 1977, 69, 663 – 667
19. Brucker, M. Studies on the incidence and cause of dental defects in children. J. Dent. Res. 1943, 22, 107 – 113
20. Brudevold, F. & Naujoks, R. Caries preventive fluoride treatment of the individual. Caries Res. 1978, 12, suppl. 1, 52 – 64
21. Clark, C.A., Fintz, J.B. & Taylor, R. Effects of the control of plaque on the progression of dental caries: Results after 19 months. J. Dent. Res. 1974, 53, 1468 – 1474
22. Curson, I. & Manson, J.D. A study of a group of dental students including their diet and dental health. Br. Dent. J. 1965, 119, 197 – 205
23. Dale, J.W. Toothbrushing frequency and its relationship to dental caries and periodontal disease. Aust. Dent. J. 1969, 120 – 123
24. Fosdick, L.S. The reduction of the incidence of dental caries. 1. Immediate tooth-brushing with a neutral dentifrice. J. Am. Dent. Assoc. 1950, 40, 133 – 143
25. Granath, L.E., Martinsson, T., Matsson, L., Nilsson, G., Schrøder, U. & Søderholm, B. Intraindividual effect of daily supervised flossing on caries in schoolchildren. Community Dent. Oral Epidemiol. 1979, 7, 147 – 150
26. Gülzow, H.J. Die Mundhygiene und ihren Beziehungen zum marginalen Parodontium und zur Kariesfrequenz. Dtsch. Zahn-Mund-Kieferhlk. 1965, 44, 97 – 105
27. Hamp, S.E., Lindhe, J., Fornell, J., Johansson, L.-Å. & Karlsson, R. Effect of a field program based on systematic plaque control on caries and gingivitis in schoolchildren after 3 years. Community Dent. Oral Epidemiol. 1978, 6, 17 – 23
28. Hansen, F. & Gjermo, P. The plaque-removing effect of four toothbrushing methods. Scand. J. Dent. Res. 1971, 79, 502 – 506
29. Hewat, R.E.T., Abraham, M. & Rice, F.B. An experimental study on the control of dental caries. New Zeal. Dent. J. 1950, 46, 78 – 85
30. Hewat, R.E.T., Rice, F.B. & Eastcott, D.F. Study on the effects of dental hygiene on the development of dental caries in student dental nurses. New Zeal. Dent. J. 1952, 48, 42 – 45
31. Hine, M.K. Prophylaxis, toothbrushing, and home care of the mouth as caries control measures. J. Dent. Res. 1948, 27, 223 – 234
32. Holloway, P.J. & Teagle, F. The relationship between oral cleanliness and caries incre-

ment. J. Dent. Res. 1976, Special issue D, D106
33. Horowitz, A.M., Suomi, J.D., Peterson, J.K. & Beverly, A.L. Effects of supervised daily dental plaque removal by children II. 24 months results. J. Publ. Health Dent. 1977, 37, 180 – 188
34. Karlsson, B-S. & Larsson, Y. Den kariesförebyggande effekten av mekanisk plackkontroll bland 13 – 16 åriga skolbarn. Tandläkartidn. 1976, 68, 1085 – 1086
35. Kerr, D.N. & Kesel, R.G. Two-year control study utilizing oral hygiene and ammoniated dentifrice. J. Am. Dent. Assoc. 1951, 42, 180 – 188
36. Kjærheim, V., Fehr, F.R. von der, & Poulsen, S. A two year study of professional mechanical toothcleaning on schoolchildren in Oppegård, Norway. Community Dent. Oral Epidemiol. 1981, in press
37. Klock, B. and Krasse, B. Effect of caries-preventive measures in children with high numbers of S.mutans and lactobacilli. Scand. J. Dent. Res. 1978, 86, 221 – 230
38. Koch, G. & Lindhe, J. The effect of supervised oral hygiene on the gingiva of children. J. Periodontal. Res. 1967, 2, 64 – 69
39. Koch, G. & Lindhe, J. The state of the gingivae and the caries-increment in schoolchildren during and after withdrawal of various prophylactic measures. In: McHugh, W.D. ed. Dental Plaque, Livingstone, Edinburgh 1970, pp 271 – 281
40. Lindhe, J. & Axelsson, P. The effect of controlled oral hygiene and topical fluoride application on caries and gingivitis in Swedish schoolchildren. Community Dent. Oral Epidemiol. 1973, 1, 9 – 16
41. Lindhe, J. & Nyman, S. The effect of plaque control and surgical pocket elimination on the establishment and maintenance of periodontal health. A longitudinal study of periodontal therapy in cases of advanced disease. J. Clin. Periodontol. 1975, 2, 67 – 79
42. Lindhe, J., Axelsson, P. & Tollskog, G. Effect of proper oral hygiene on gingivitis and dental caries in Swedish schoolchildren. Community Dent. Oral Epidemiol. 1975, 3, 150 – 155
43. Lindhe, J., Koch, G. & Månsson, U. The effect of supervised oral hygiene on the gingiva of children. J. Periodont. Res. 1966, 1, 268 – 275
44. Löe, L., Theilade, E. & Jensen, S.B. Experimental gingivitis in man. J. Periodontol. 1965, 36, 177 – 187
45. Löe, H., Fehr, F.R. von der & Rindom Schiøtt, C. Inhibition of experimental caries by plaque prevention. The effect of chlorhexidine mouthrinses. Scand. J. Dent. Res. 1972, 80, 1 – 9
46. Løvdal, A., Arnø, A., Schei, O. & Waerhaug, J. Combined effect of supragingival scaling and controlled oral hygiene on the incidence of gingivitis. Acta Odontol. Scand. 1961, 19, 537 – 555
47. Malmberg, E. Tuveforsøket. Tre års profylaktisk behandling av 16 – 19-åringer. Tandläkartidn. 1976, 68, 1087 – 1089
48. Mansbridge, J.N. The effects of oral hygiene and sweet consumption on the prevalence of dental caries. Br. Dent. J. 1960, 109, 343 – 348
49. Marthaler, T.M. Decrease of DMF-levels 4 years after the introduction of a caries-preventive program; observations in 5819 schoolchildren of 20 communities. Helv. Odontol. Acta 1972, 16, 45 – 68
50. Marthaler, T.M. Reduction of caries, gingivitis and calculus after eight years of preventive measures – observations in seven communities. Helv. Odontol. Acta 1972, 16, 69 – 83
51. McCauley, H.B. & Frazier, T.M. Dental caries and dental care needs in Baltimore school children. J. Dent. Res. 1957, 36, 546 – 551
52. McHugh, W.D., McEwen, J.D. & Hitchin, A.D. Dental disease and related factors in 13-year-old children in Dundee. Br. Dent. J. 1964, 117, 246 – 253
53. McKendrick, A.J.W. Toothbrushing and dental health. Prevent, 1972/73, 1, 37 – 40
54. Miller, J. Relationship of occlusion and oral cleanliness with caries rates. Arch. Oral Biol. 1961, 6, 70 – 79
55. Murray, J.J. Fluorides in caries prevention. John Wright & Sons Ltd., Bristol 1976, 99 – 113 and 132 – 146
56. Newbrun, E. Cariology. The Williams & Wilkins Company, Baltimore Md, USA 1978. pp 257 – 258
57. Plasschaert, A.J.M. & König, K.G. The effect of information and motivation towards dental health, and fluoride tablets on caries in schoolchildren. I. Increment over the initial 2-year experimental period. Int. Dent. J. 1974, 24, 50 – 65
58. Poulsen, S., Agerbaek, N., Melsen, B., Korts, D.C., Glavind, L. & Rølla, G. The effect of professional toothcleansing on gingivitis and dental caries in children after 1 year. Community Dent. Oral Epidemiol. 1976, 4, 195 – 199
59. Ripa, L.W. Correlation between oral hygiene status, gingival health and dental caries in school children. J. Prev. Dent. 1974, 1, 28 – 38
60. Ripa, L., Berenie, J. & Leske, G. The effect of toothbrushing frequency of dental caries in school children: Reassessment after 2½ years. J. Dent. Res. Special Issue B 1976, 55, B 223
61. Ripa, L.W. Berenie, J.T. & Leske, G.S. The effect of professionally administered biannual prophylaxes on the oral hygiene, gingival health, and caries scores of school children. Two year study. J. Prev. Dent. 1976, 3, 22 – 26
62. Sen Savara, B. & Suher, T. Dental caries in children one to six years of age as related to socioeconomic level, food habits, and toothbrushing. J. Dent. Res. 1955, 34, 870 – 875
63. Silverstein, S., Gold, S., Heilbron, D.,

Nelms, D. & Wycoff, S. Effect of supervised deplaquing on dental caries, gingivitis and plaque. J. Dent. Res. Special Issue A 1977, p. A 85

64. Smith, A.J. & Striffler, D.F. The reported frequency of toothbrushing as related to the prevalence of dental caries in New Mexico. J. Pub. Health Dent. 1963, 23, 159 – 175
65. Suomi, J.D., Greene, J.C., Vermillion, J.R., Doyle, J., Chang, J.J. & Leatherwood, E.C. The effect of controlled oral hygiene procedures on the progression of periodontal diseases in adults: Results after third and final year. J. Periodontol. 1971, 42, 152 – 160
66. Sutcliffe, P. A longitudinal clinical study of oral cleanliness and dental caries in school children. Archs Oral Biol. 1973, 18, 765 – 770
67. Toto, P.D., Sawinski, V.J. & Evans, C. The effects of instructed toothbrushing on the cleanliness of teeth and DMF: An eighteen-month study. J. Oral Therap. & Pharmac. 1967, 3, 354 – 358
68. Trubman, A. Oral hygiene: its association with periodontal disease and dental caries in children. J. Am. Dent. Assoc. 1963, 67, 348 – 351
69. Tucker, G.J., Andlaw, R.J. & Burchell, C.K. The relationship between oral hygiene and dental caries incidence in 11-year-old children. Br. Dent. J. 1976, 141, 75 – 79
70. Vestergaard, V., Moss, A., Pedersen, H.O. & Poulsen, S. The effect of supervised tooth cleansing every second week on dental caries in Danish school children. Acta Odontol. Scand. 1978, 36, 249 – 252
71. Wright, G.Z., Banting, D.W. The effect of interdental flossing on the incidence of proximal caries in children. J. Dent. Res. 1977, 56, 574 – 578
72. Wright, G.Z., Banting, D.W. & Feasby, W.H. The Dorchester dental flossing study: final report. Clin. Prev. Dent. 1979, 1, 23 – 26
73. Helsedirektoratet, Tannlegekontoret, Kariesepidemiologisk undersøkelse av folketannrøktas frie klientell. Norsk Tannlægeforen. Tid. 1973, 83, 2 – 6